MANUAL FOR USE 1502 1507

Deviation Test Bridge

Type 1502 & 1507

Adapted for the checking of resistances, capacities and inductances in industrial production and laboratories.

Beat frequency oscillators
Low frequency oscillators
Deviation test bridges
Strain gauge apparatus
Frequency measuring bridges
Distortion measuring bridges
Heterodyne voltmeters
Audio frequency spectrometers
Frequency analyzers
Level recorders, a. c. and d. c.
Automatic frequency response recorders
Automatic A. F. spectographs
Logarithmic potentiometers
Noise level potentiometers
Recording paper
Polar diagram recorders
Vacuum tube voltmeters
Wide range vacuum tube voltmeters
Diode voltmeters
D. C. voltmeters
Megohmmeters
Microphone amplifiers
Impact sound generators
Acoustic standing wave apparatus
Artificial ears
Condenser microphones
Microphone calibration apparatus
Vibration pick-ups
Integration networks
Rotary selectors
Universal selectors
Frequency response tracers
Conductivity meters
Electronic counters
Counting rate meters
Impulse generators
Portable dose rate meters
Portable counting rate meters
G. M. tubes & accessories

BRÜEL & KJÆR

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DEVIATION TEST BRIDGE

Type 1502 and 1507

The bridge is intended for testing components such as resistors, capacitors and inductors, and will read directly any deviation from the standard. The instrument comprises two arms of a Wheatstone Bridge; the remaining arms are formed by the external standard and the measuring object, and an a.c.voltage is supplied by a built-in generator. The frequency is 1000 c/s in the Type 1502 Bridge

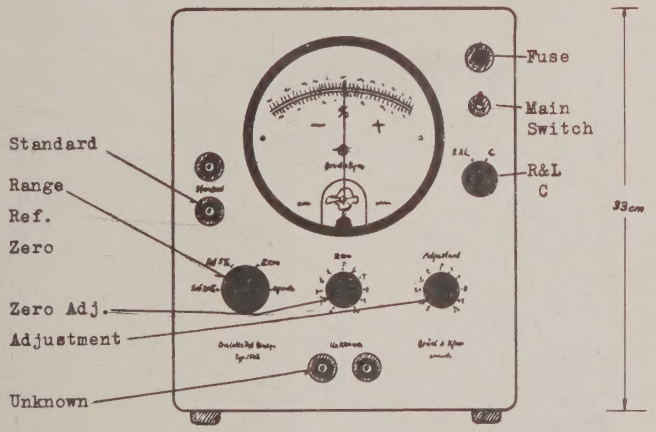


Fig. 1.

and 50 kc/s in Type 1507 Bridge. The galvanometer voltage is amplified and fed to a modulator circuit together with the generator voltage, and a d.c. meter in this circuit will indicate the deviation as a per cent calibration.

The bridge has two ranges with full deflections for -7% to +8 % and -25% to +33% respectively, and for adjustment and control it

contains a set of resistors, whose ratios are indicated by red markings on the meter scale.

When the deviation indicated is 0. the real deviation is less than 0.1% and the full scale accuracy better than 5%. The moving-coil instrument is slightly under-critically damped to secure maximum speed, and perfectly protected against overload.

The bridge is to a certain extent insensitive to hum voltages owing to the fact that the modulator responds only to voltages having the generator frequency. However, when the hum voltage is so high as to saturate the amplifier, the gain will decrease and the meter reading will be too low.

When measuring high impedances the meter reading will also be too low, because the bridge is loaded by the amplifier input circuit. This is compensated for within the stated accuracy by increasing

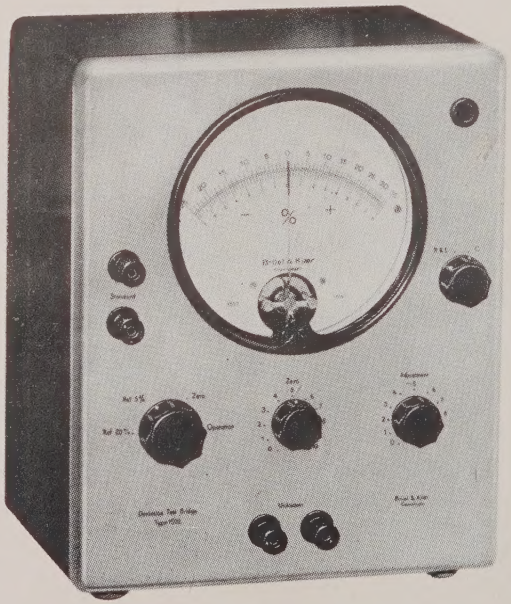


Fig. 2.

the generator voltage according to an adjustment curve, whose values are used instead of the red markings on the scale.

The measuring range for the Type 1502 Bridge covers resistances between 10 Ω and 10 MΩ, capacitances between 50 μμF and 10 μF, and self-inductances between 2 mH and 100 H, approximately. For the Type 1507 Bridge, the ranges are 20Ω to 100 kΩ, 25 μμF to 0.1 μF, and 50 μH to 2 H. When measuring capacitance the difference between the power factor of the standard and the measuring object should not be too great. This holds good for measurements of inductances too, and here it is furthermore a condition that the reactance at the generator frequency is high in comparison with the resistance, and that no resonance occurs.

The bridge may be used as a direct-reading measuring instrument for capacitances. Two equal high capacitances are connected across the Standard and Unknown terminals, and the capacitance to be found can then be measured as a per cent increase of the fixed known value. By varying the fixed known capacitance different measuring ranges can be obtained. 100 μμF will give the ranges 0-8 μμF and 0-33 μμF, while 10 μF will give the ranges 0-0.8 μF and 0-3.5 μF, corresponding to the meter deflections of 0-8% and 0-33%.

By using two fixed resistors the bridge can similarly serve as an ohmmeter. The resistance to be measured is connected in series with one of the two fixed resistors.

Finally, the apparatus may be used for measuring and controlling other physical quantities which are transformable into impedance variations; for instance stress may be measured by the change in the resistance, permeability or conductivity of the material, temperature by the change in resistance, etc.

The European model is intended for use on 115, 127, 150 or 220 volts a.c., 40-60 c/s. Switching to the different line voltages is made by means of a screwdriver through a hole in the back plate. A pilot disc ganged with the switch indicates the line voltage to be connected. The American model is designed for 115 volts, 60 c/s. The power consumption for both models is about 40 watts. The anode voltage to the amplifier is stabilized by a neon tube. A variation

of 5% in the power voltage will influence the meter deflection by about 2%, the zero point being independent of the line voltage.

Operation

The apparatus is connected to a power line of the voltage stated on the back. When the current is switched on, the meter lamps will light immediately, and in about 30 seconds the tube cathodes will be warm.

The standard and the object to be measured are connected to the terminals of the apparatus, and the meter pointer is set to 0 by means of the knob marked "Zero", the selector to the left of the apparatus being set to position "Zero".

When it is wished to use the inner scale of the instrument, the selector is set to "Ref.5%" and the knob marked "Adjustment" is turned until the pointer stands on the red marking at 5% on the inner scale. The selector is then turned to "Operation" and the apparatus is then ready for use.

The adjustment is made in the same way when the upper scale is used; the selector is set to "Ref.20%" and the red marking at 20% on the upper scale is used.

The adjustment may drift a little, particularly during the first minutes, and should therefore be checked now and then.

When measuring high impedances, the values obtained from the adjustment curves should be used instead of the read markings on the scales.

The switch on the right of the apparatus has two positions. "R & L" for measurement of resistance and self-inductance, and "C" for measurement of capacitance.

With regard to hum voltages the apparatus should be grounded (the terminal on the back plate). The standard and the objects to be measured should be placed together with the bridge on a grounded metal plate. None of the terminals of the apparatus is in connection with the chassis. The upper of the terminals to the left and

the terminal to the right at the bottom are connected to chassis through resistances of about 10 Ω and have an a.c. voltage of maximum 5 volts in relation to chassis. The other two terminals, marked in white, are mutually connected and lead to the input circuit of the amplifier.

If it is desired to measure objects having one pole grounded, this pole should be connected to the right "Unknown" terminal, and the grounding of the cabinet should be omitted. The capacity of the apparatus to ground is thus connected across one of the built-in ratio resistances and should consequently be kept as low as possible.

The standards used in the measurements should be of the same kind as the object measured, and the connecting wires should be short and placed alike. In the normal measuring range small displacements will, however, be of no great importance. Paper condensers of common quality may thus be compared with standards of mica or polystyrene without the inaccuracy exceeding 0.5%, and in measurements of resistors, resistance boxes may be used, even though hereby some capacitance is introduced into the measuring circuit.

Outside the normal measuring range, i.e., in measurements of so small capacitance and so high resistance that the adjustment is made by means of the curves instead of by the red markings on the scales, it is of great importance that the standard and the unknown have the same phase angle. A standard of the same type as the object measured absolutely must be used. Furthermore, it is very important that no extra capacitance or leakage be introduced into the input circuit of the amplifier, i.e., between the chassis (or ground) and the two terminals marked in white.

Applications

Measurements of Resistors, Capacitors and Coils.

Fig. 3 shows a practical jig in which resistors and capacitors of small sizes may be placed. The contact is made via two sets of razor blades, always ensuring a good contact to the wires of the objects.

It is also recommended to place the standards in our small Standard Box Type 1502a, see Fig.4. The box consists of a circular bottom plate where two plugs with springs are placed with the correct spacing. The standard resistor, capacitor or inductance is soldered to the ends of the plugs and a cylindrical cover is placed over

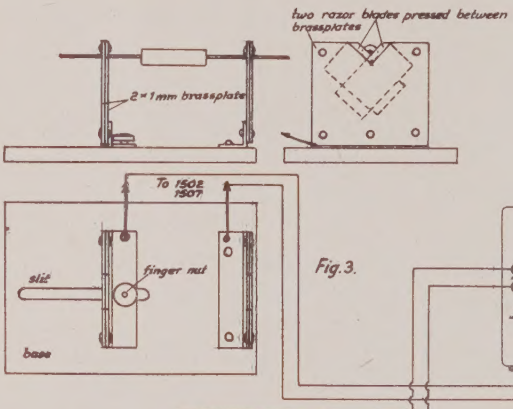


Fig.3.

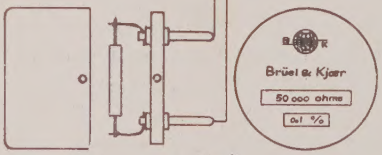


Fig. 4.

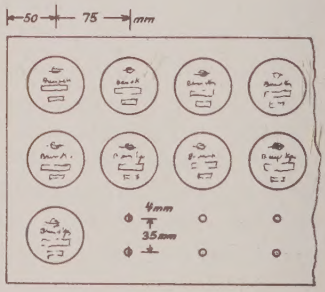


Fig. 5.

the standard. The value of the standard is engraved on the cover. It is worth while making these standards carefully and attractively, and keeping them in some practical way whereby they may easily be found when required. A good solution of this last problem is to fix a board to the wall with 4 mm holes drilled at a 35 mm spacing. The holes are made vertically above each other allowing the engraved text to be read in the correct position. In this way an excellent survey of the standards is obtained.

In the production of very small capacity standards the final fine-adjustment should be made on the bridge itself. The standard is placed on "Standard" and the primary standard on "Unknown", possibly via that jig which would generally be used in the measurements. This manner of procedure ensures capacitative balance in bridge and jig.

When bridge, jig and components are conveniently placed in relation to the operator, an average efficient girl should be able to check and select up to 4000 resistors or small capacitors per hour.

Measurements of Resistors and Capacitors in Laboratories.

It will be very time-saving to have Type 1502 permanently connected to the laboratory standard resistance box and Type 1507 connected to the variable standard condenser for quick measurements of resistors and small capacitors respectively. The standard is then varied until the Deviation Test Bridge indicates zero. This method will be much faster than using a Wheatstone Bridge with magic eye or galvanometer.

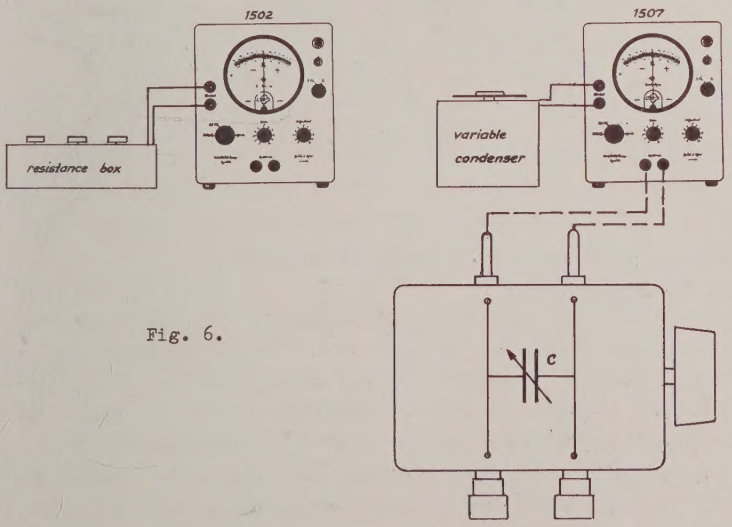


Fig. 6.

For use in attenuators or similar it will often be convenient in laboratory work to select the components in percentage deviation. In measurements of condensers it will be practicable to place a small box, shown in Fig. 6, across the terminals marked "Unknown", the box containing a small variable condenser connected across the terminals for balancing the zero capacitance in the standard condenser.

Checking of Coils for Short-Circuit Turns

For checking coils in transformers, chokes, inductances etc., a set-up as indicated in Fig. 7 is very useful. Two identical measuring coils with long iron cores are balanced on the bridge, and the coil under test is then placed over the end of one of the cores.

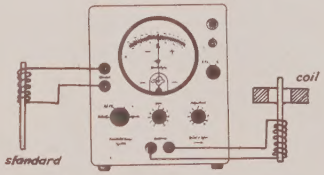


Fig. 7.

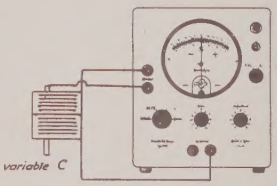


Fig. 8.

If there is a short-circuit in the coil, the induction in the coil will react with the balanced coil, and deflect the meter pointer.

Balance of Coupled Variable Condensers and Potentiometers

For adjustment of coupled variable condensers the set-up shown in Fig.8 will be practical. The two stators are connected respectively to the upper left and lower right terminals of the bridge, while the rotors, which are as a rule connected together, are joined to one of the two remaining terminals. The balance expressed in % deviation may then be checked for all positions of the rotor. A similar set-up can be used with coupled potentiometers and variable resistors.

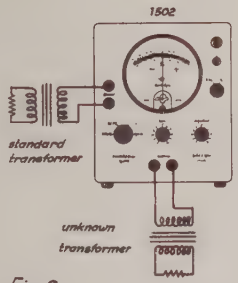


Fig. 9.

Checking of Transformers.

The Deviation Test Bridge is also a suitable apparatus for checking transformers for amplifiers, hearing aids, etc. The set-up is shown in Fig.9. The transformer with its correct load on the output side is connected to the terminals marked "Unknown". A perfect transformer loaded with the same impedance is used as standard, and defects in either coils, turn numbers or laminations may then be observed. As a rule, Type 1502 will be the most suitable apparatus for these measurements, except for extremely small transformers, where Type 1507 may be used. When measuring very large transformers it may happen that the capacity is so high that it will disturb the measurements even on Type 1502. Such transformers have to be measured at a very low frequency.

Direct-Reading Measurements of Capacitances

The Deviation Test Bridge Type 1502 or 1507 may be used as a direct-reading measuring instrument of capacitances. Two equal condensers of exactly known capacitance are, as shown in Fig. 10, connected across the "Standard" and "Unknown" terminals, one to each terminal. The capacitance to be found is measured as a per cent increase of the fixed known value. By choosing the fixed condensers as pure powers of 10 the direct readings will be simplified. To make the adjustment easier it will be practical to have part of the capacitance on "Standard" placed as a small trimmer condenser.

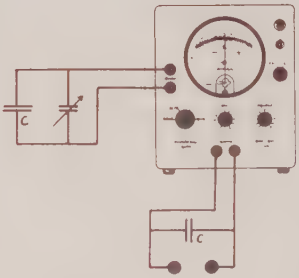


Fig. 10.

The procedure is then as usual: Set zero point and adjustment to reference, then switch to "Operation" and bring the pointer to zero in the middle of the scale by means of the adjustable part of the fixed capacitance. When the fixed condensers are very small the reference adjustment should be done in accordance to the adjustment curves on p.12. The following table shows ranges and adjustments to reference for various fixed standards chosen as powers of 10.

Fixed Capacitors	Direct Reading Range	Adjustment to Reference. %.	
		1502	1507
2 x 100 pF	0 - 7 pF 0 - 33 -	5.80 24.1	5.42 22.8
2 x 1000 pF	0 - 70 - 0 - 330 -	5 20	5 20
2 x o.01μF	0 - 700 - 0 - 3300 -	5 20	5 20
2 x o.1 μF	0 - 7000 - 0 - 33000 -	5 20	5 20
2 x 1 μF	0 - o.07 μF 0 - o.33 -	5 20	
2 x 10 μF	0 - o.7 - 0 - 3.3 -	5 20	

Direct-Reading Measurements of Resistances

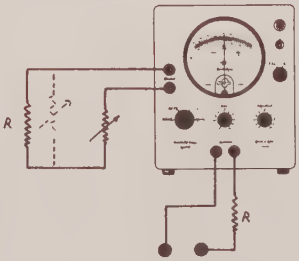


Fig. 11.

In a similar way as for capacitances it is possible to use the Deviation Bridge as a direct-reading ohmmeter. As illustrated in Fig. 11 two fixed resistors have to be used analogically to the two capacitances, but the resistance under test has to be connected in series with one of the fixed R. The small adjustable fraction of the other fixed R may be connected

either in series or in parallel with R. If series connection is used, the adjustable R need only be a few per cent of the total value of the fixed resistance, while it has to be great compared to the total resistance if connected in parallel.

Fixed Resistance	Direct Reading Range	Adjustment to Reference.%.	
		1502	1507
2 x 10 Ω	0 - 0.7 Ω	5	
	0 - 3.3 -	20	
2 x 100 Ω	0 - 7 -	5	5
	0 - 33 -	20	20
2 x 1 kΩ	0 - 70 -	5	5
	0 - 330 -	20	20
2 x 10 kΩ	0 - 0.7 kΩ	5	5
	0 - 3.3 --	20	20
2 x 100 kΩ	0 - 7 kΩ	5	5
	0 - 33 - -	20	20
2 x 1 MΩ	0 - 70 - -	5	
	0 - 330 - -	20	
2 x 10 MΩ	0 - 0.7 MΩ	8.02	
	0 - 3.3 - -	32	

Special Laboratory Applications

The Deviation Bridge finds numerous special applications in laboratories for measuring and controlling physical quantities which are transferable into impedance variations by means of special gauges or pick-ups. Some of the measurements which have been carried out with one of the Bridges are mentioned below.

Measurement	Gauge or Pick-up	Bridge
Mechanical stress in:		
Wood, plastics, etc.	Wire resistance gauge	1502
" " "	Carbon paste on material	1502
all materials	Condenser pick-up	1507
reinforced concrete	Nickel steel permeable pick-up	1502
Force (dynamometer)	Condenser in steel ring	1507
Temperature	Thermistors	1502
Temperature flow	2 thermistors in static balance	1502
Conductance in liquids	Platinum electrodes	1502
" " soils	Standard soil gauge	1502
Small relative movements	Inductive coil pick-up	1507
Liquid levels in tanks	Potentiometer moved by the level	1502
Determination of:		
Extremely small loads	Capacitive micro balance	1507
moisture in cardboards	Capacitive test arrangements	1507
iron in paper, cotton, etc.	Inductive gauge	1507

Trouble Shooting

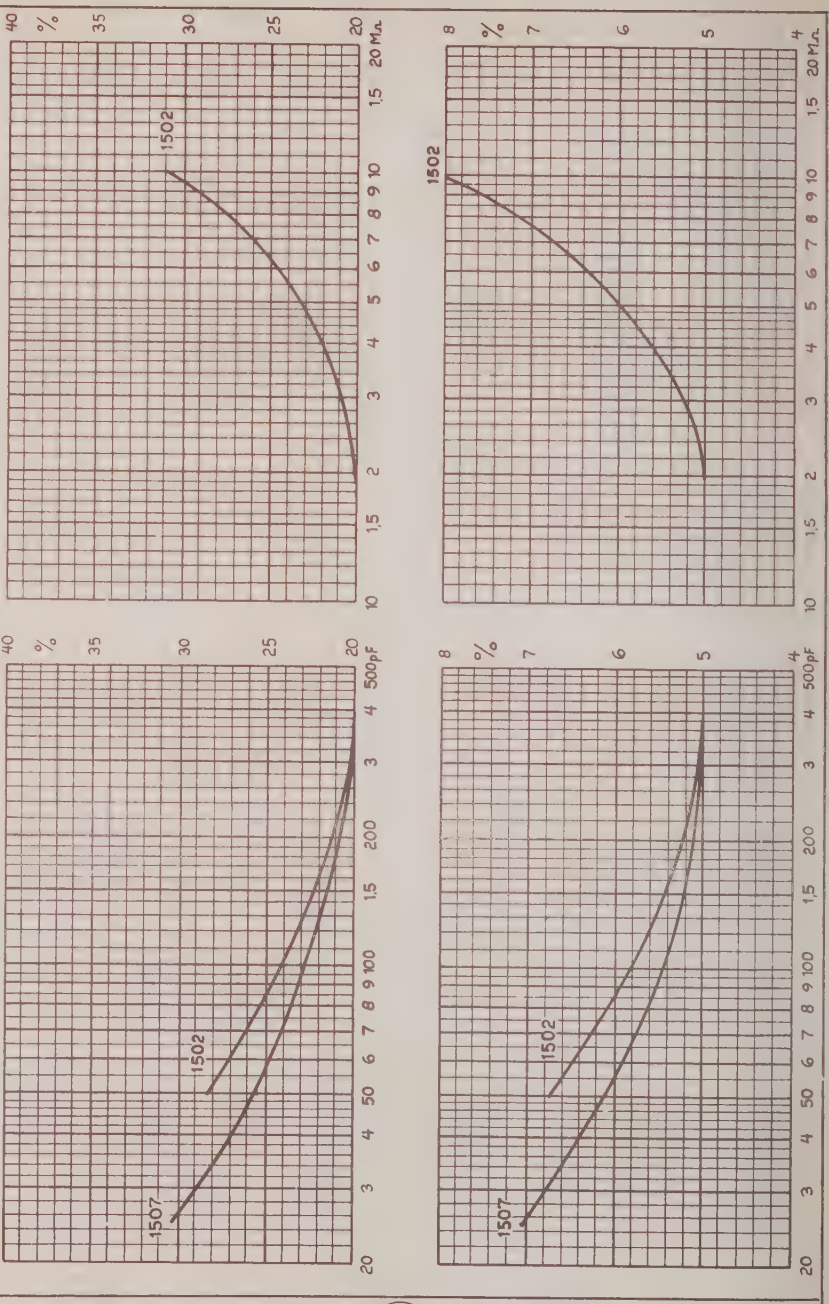
Symptom	Probable Cause	Treatment
Apparatus dead, no scale light.	Fuse or main switch defective.(In Eur.model the voltage selector 03)	Replacement.
App. dead, scale light intact,stabilizer tube does not light.	No anode voltage, rectifier tube or electrolyte defective.	Replacement.
Apparatus dead, scale light intact, stabilizer tube lights.	a) Oscillator does not oscillate (normal sec. voltage approx 8 V in 1502,approx 14 V in 1507 b)Q1 Q2(1502),V10 (1507) c) meter, zero potentiometer or R7-8 defective.	Check tube V4, transformer T2, and C13 in 1502,and C11 in 1507. Replacement Check these parts.
Zero adjustment intact, app. does not work on "Ref" and "Operation".	a)Output stage does not work, no a.c. on bridge. Normal voltage max. 7 V in 1502, 10 V in 1507. b) Preamplifier does not work.	Check V1, T1, C6, P1, R1, C7, R6. Check V5-6 and all component belonging hereto.
Zero adjustment and "Ref" functioning, app. does not work on "Operation".	Selector 01 or 02 defective.	Check or replace.
App.does not work on one of the "Ref"s.	Selector 01 or "Ref"potentiometer defective.	Cleaning or replacement.
Pointer sticks on stop.	Pointer or stop dirty.	Clean with ether or benzine(cleaner's naphta).
Instrument must be taped to bring pointer to proper position.	Steel particles in magnet, dirt in spring cone bearings.	Cleaning of meter.
Pointer quivers or moves about. App. shows too small deflections.	Amplifier hum-excited.	Ground apparatus. Screen standard and object.
Ground connection intact. Pointer wanders about, particularly on "Operation".	Interference between line harmonics and generator frequency (only 1502).	Filter line voltage. If necessary, change the generator frequency slightly by C13.
Apparatus reads too low in measurements of small impedances.	Wrong adjustment.	Both standard and object should be connected prior to"Ref" adjustment.
Apparatus reads too low in measurements of high impedances.	a) Wrong adjustment. b) Unsuitable standard or too long wires. c) Phase error in amplifier or between oscillator and output tube.	Use the curves. Use standards in small boxes on pin plugs. Check all condensers.
App. indicates wrongly at zero point of scale.	Base resistors R21-22 in 1502,R4-5 in 1507,unlike.	Check or replace.
App. indicates wrongly at extremes of scale.	V5 or V6 saturated	Check tube,anode, screen, grid and cathode resistors.

Parts List

Term	Stock Number	Mark
POTENTIOMETERS		
Carbon, log.	PL 500 kΩ	P1
Wire	PW 1 kΩ	P2
"	PW 3 kΩ	P3
"	PW 200 Ω	P4
RESISTORS		
Carbon ½ W	RC 100 Ω	R1
" 1 W	RC 10 kΩ	R2
" ½ W	RC 20 kΩ	R3
" 1 W	RC 20 kΩ	R4
Karbowid ½ W	RK 315 Ω	R6
" ½W ±3%	RK 500 Ω	R7-8
" ½ W	RK 800 Ω	R9-10
" "	RK 4 kΩ	R11
" "	RK 20 kΩ	R12
" "	RK 32 kΩ	R13
" "	RK 50 kΩ	R14
" "	RK 100 kΩ	R15
" "	RK 315 kΩ	R16
" "	RK 1 MΩ	R17-19
" "	RK 10 MΩ	R20
Wire-wound ±.1%	RW 10 Ω	R21-22
" " 10 W	RW 2 kΩ	R24
CONDENSERS		
Electrolytic	CE8µF/450	C1
Electrolytic	CE48µF/450	C2-3
Paper	CP 3 nF	C4
"	CP 5 nF	C5-6
"	CP 10 nF	C7
"	CP 20 nF	C8
"	CP o.1 µF	C9-10
"	CP o.2 µF	C11
Polystyrene	CT 1 nF	C12
"	CT 15 nF	C13

Term	Stock Number	Mark
POTENTIOMETERS		
Wire	PW 3 kΩ	P1
"	PW 1 kΩ	P2
"	PW 200 Ω	P3
Carbon, log.	PL 25 kΩ	P4
RESISTORS		
Carbon ½ W	RC 100 Ω	R1
" "	RC 5 kΩ	R2
Wire 10 W	RW 2 kΩ	R3
" ±o.1%	RW 10 Ω	R4-5
Karbowid ½ W	RK 315 Ω	R6
" "	RK 500 Ω	R7-8
" "	RK 1 kΩ	R9
" "	RK 2 kΩ	R10
" "	RK 5 kΩ	R11-12
" "	RK 32 kΩ	R13
" "	RK o.1 MΩ	R14-15
" "	RK 1 MΩ	R16
" "	RK 2 MΩ	R18
" "	RK 800 Ω	R19
" 1 W	RK 15 kΩ	R20
" "	RK 20 kΩ	R21
" "	RK 50 kΩ	R22
CONDENSERS		
Electrolytic	CE2x24µF/450	C1
Paper	CP 1 nF	C2
"	CP 5 nF	C3
"	CP 10 nF	C4-5
"	CP 20 nF	C6
"	CP o.1 µF	C7-8
Polystyrene	CT 200 pF	C9-10
"	CT 2 nF	C11

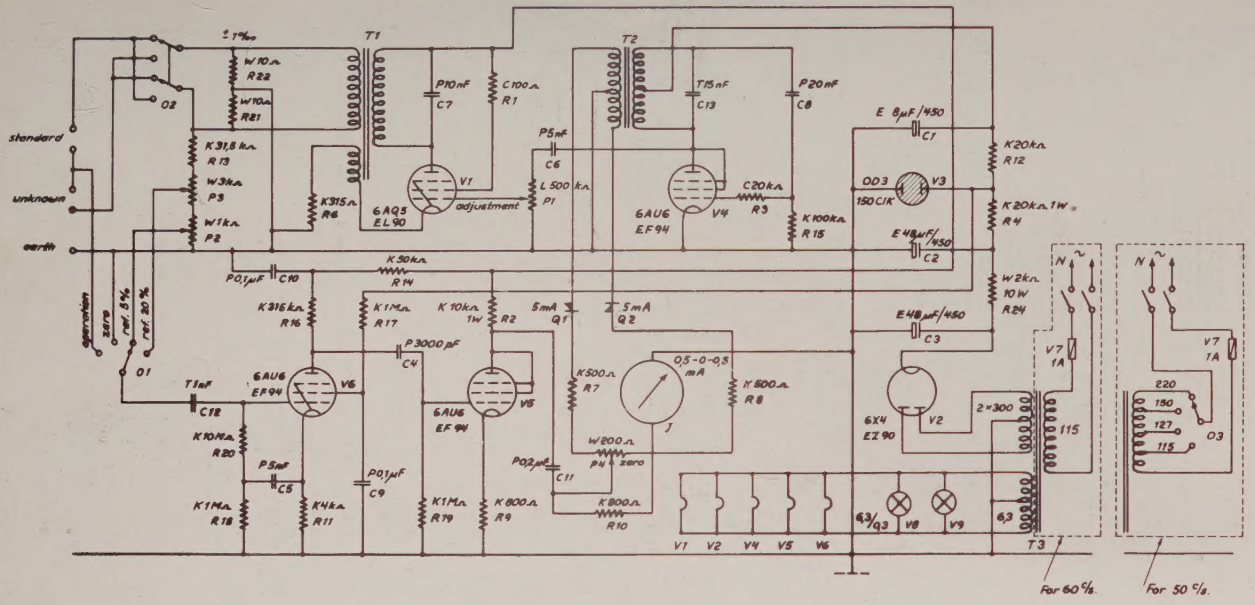
cabinet	KQ 1502	oscill. transf. (1502)	TU 1201
cabinet, bolt	YP 0004	output transf. (1502)	TU 3201
cap nut	YM 0001	copper oxide rectifier (1502)	QV 0004
cap nut for grounding	YM 0003	moving coil meter (1502)	IM 1502
bakelite knob	SN 0980	moving coil meter (1507)	IM 1507
bakelite knob	SN 0938	glass for meter	IL 3188
binding post	JK 6263	tube cap for 6AU6	DT 0002
insulating washer	YO 1502	spring for 6AU6	DL 0003
insulating washer	YO 0501	tube cap for 6X4	DT 0004
insulating washer	YO 2502	spring for 6X4	DL 0004
telephone bushing	JT 6201	oscill. transf. (1507)	ZS 0010
rubber foot for cabinet	DF 7009	output transf. (1507)	TU 4024
meter lamp socket	JO 0001	power transf. (US model)	TN 1070
main switch	MN 0263	power transf. (Eur.model)	TN 0122
range switch	OR 1502	power line socket (US model)	UP 0010
R-L-C switch	OS 1502	power voltage selector (Eur.model)	OA 0001
fuse socket	JS 0961		



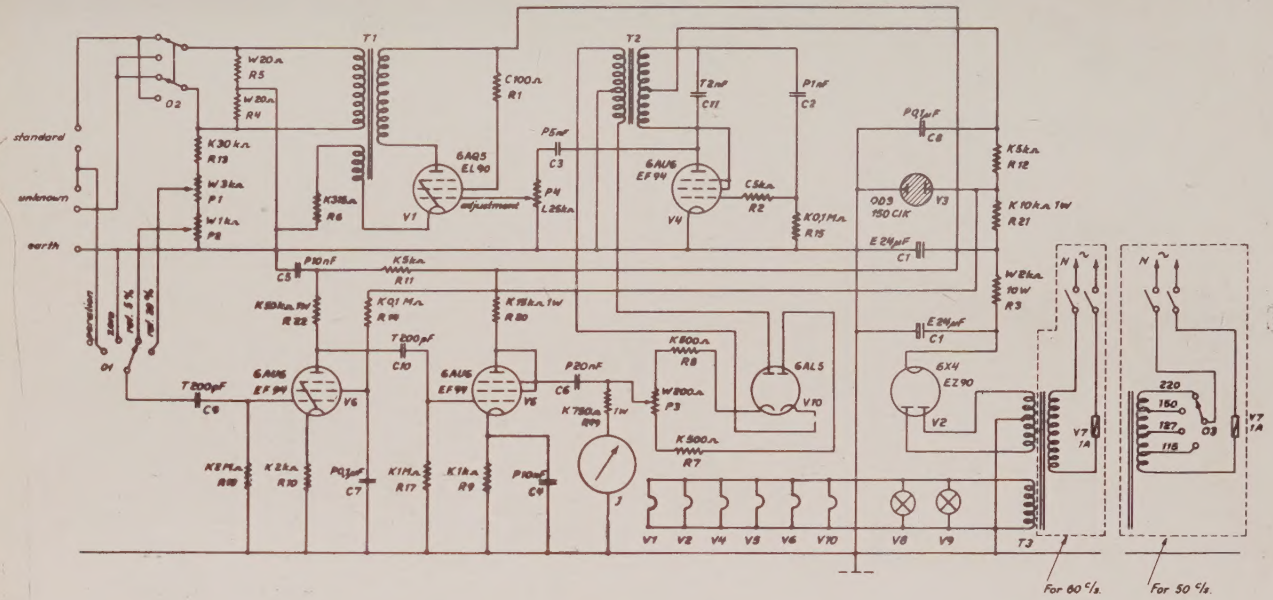
Deviation Test Bridge

Brüel & Kjær
Copenhagen

Type	1502–1507	p. 14	Date April 1951.



Correction dates					Deviation Test Bridge	Brüel & Kjær Copenhagen.
					Type 1502	p. Date 11-10-52



Correction dates					Deviation Test Bridge	Brüel & Kjær Copenhagen.
					Type 1507	P. Date 12-10-52

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